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METHODS OF DETERMINING THE ECONOMIC PRODUCTIVITY OF MUNICIPAL ENTERPRISES.¹

THIS topic must be defined and limited before it can be profitably discussed. Obviously it does not cover all municipal enterprises. No practical object would be gained by a discussion of the economic productivity of roads or parks or sewers or police. They all have an economic side, and might be justified from that standpoint. But it is needless to justify what everyone accepts. On the other hand there are classes of municipal enterprises the economic productivity of which is a matter of controversy. Means of transportation within the municipality, or public docks, may serve as examples. It is to enterprises of this character that the subject may be considered as limited. The question, therefore, presents itself: By what test may municipal enterprises of this class be distinguished from other municipal enterprises? The best test is probably to be found in a consideration of the main purpose of the enterprise. If it aims primarily at rendering an economic service it may fairly be tested by its economic productivity, but otherwise not. For example, a sewerage system is economically productive. By improving the health of citizens and lengthening their lives it increases their productive power. But life and health are higher aims than production. We produce to live rather than live to produce. Hence the benefit of a sewerage system should be measured in terms of decreased mortality rather than in terms of increased productivity. An example nearer the division line is found in the case of a water supply. Where the population is crowded the water supply is second only to the sewerage system as a means to life and health. Under such conditions the economic advantages are not the

¹ Paper read by request before the American Social Science Association, September 1, 1896.

final or proper test to apply. But with a sparser population the question of health may sink into the background and the superior convenience or cheapness of water in pipes over water in cisterns, wells, or springs may become the more important consideration. A last example may be permitted. Public lights were introduced as a means of increasing public safety and decreasing crime. They still are of much importance for that end. But the entire lighting, heating, and power system, of which the public lights are usually but a small part, can hardly be said to exist primarily for the prevention of crime. The economic service it renders to the community is probably greater than its service as a substitute for the police. Accordingly a municipal enterprise of this character may be tested by its economic productivity.

The question, then, may be limited to the methods of determining the economic productivity of such municipal enterprises as aim primarily at economical production. Certain municipal enterprises are merely or mainly devices for rendering economic services cheaply and well. Their efficiency must be determined by comparing them with other devices for rendering equivalent services. The latter may be divided into private enterprises regulated mainly by competition, and private enterprises regulated both by competition and by governmental interference. This leads to a final limitation of the question, viz., the methods of comparing the economic productivity of municipal enterprises aiming at economic production with private enterprises rendering similar services and more or less subject to governmental control.

It may be noticed in passing that the final decision upon the wisdom or folly of such municipal enterprises must be influenced by many considerations besides the economic productivity of the ventures. The general theory of our law and political science is adverse to a wide extension of the functions of municipalities in such directions. The not infrequent corruption and the more frequent incompetency of our city governments are practical arguments in favor of the same position. The tend-

ency of such changes is often considered to be towards undermining those powers of private initiative and of voluntary coöperation which are our Saxon birthright. On the contrary, the high-handed procedure of many corporations holding public franchises, the excessive profits they often actually secure and more often are firmly believed to secure, the power exercised by such corporations in municipal or even in state affairs, when their interests are at stake, are arguments entirely aside from the present phase of the subject, and yet of great, perhaps of decisive, weight in forming the final conclusion.

It must, I think, be admitted that it is not a function of government, whether state or municipal, to undertake enterprises for profit. Some other end more clearly within the range of governmental action must be found in order to warrant the proposed extension of powers, but, that found, the profit or lack of profit may have a practical, argumentative force. For example, the recent legislation in South Carolina on the liquor traffic cannot be justified merely by showing the state management to be profitable, but its profits, if permanent and large, will have a tendency to convince the taxpayer of the wisdom of the change.

After merely noting that such considerations are here irrelevant, I pass to the central question: How may the economic productivity of municipal and private enterprises be measured and compared?

In the first place the method must be statistical. While in the natural sciences various methods of measurement are employed, in the social sciences all methods of measurement are statistical. Social phenomena are so variable in time and place that we never meet the same concrete condition twice, as we do in the natural sciences. Hence no unvarying units are possible. On the contrary, the variations are usually wide and often inexplicable. But if any trustworthy generalizations are to be obtained, they must come through the elimination of these variations. This is secured by the so-called law of large numbers, the basis of statistics. It rests on an arbitrary division of

the causes at work in any case into two classes, the accidental or disturbing or varying causes, and the essential or primary or fundamental causes, and affirms that if a sufficiently large number of instances be observed and the results averaged, the first group of causes will be more or less completely eliminated, and the effects of the second group thereby made obvious. If, for example, a sufficiently large number of electric-light plants all agreeing in the one characteristic of being conducted by the municipality, and another series all agreeing in the one characteristic of being under private control, be carefully observed and the results averaged, it is assumed by this law that the numerous differences of the members of each series among themselves would cancel in the averages, and that the difference between the two averages would express the difference of effect resulting from the one constant difference, viz., that in the mode of management.

But it is, perhaps, erroneous to speak of the statistical method. There is rather a series of methods all possessing the common characteristic just described and therefore statistical, but differing in many of their details. A student familiar with one group of these methods, as I am somewhat familiar with the methods of population statistics, is not thereby constituted a good guide through the mazes of another group, *e. g.*, financial statistics. I must confine myself, therefore, to certain general statements and not attempt to enter into details.

A fundamental and much neglected requisite of sound statistical work is that of careful definition. In this respect the European statisticians are in advance of us. For reasons which it would be tedious to state here definition is far more important in studying such phenomena than it is in the field of the natural sciences. It is the only way in which we can avoid the difficulties involved in the constant flux of social phenomena and be certain that we mean the same thing from moment to moment. For each form of municipal enterprises investigated a whole series of more or less familiar terms will be found, the exact meaning of which for that investigation should be fixed, and

whenever after in the course of the study that term is used it should be only with the agreed significance.

The economic productivity of municipal enterprises may be measured only by comparing their efficiency with that of similar private enterprises. But the two have diverse ends in view. The aim of a municipal enterprise is to satisfy the voters; the aim of a private plant is to earn money for the corporation. Hence they are not likely to render the same service except occasionally and by accident. To be sure, one most important means of pleasing the voters is by convincing them that their money is being saved and their taxes reduced. But the facts may readily be so presented as to convey a false impression to the public and perhaps as many voters would be influenced by a policy of generous or lavish display as by a favorable balance sheet. So, too, a most important means of earning money for a corporation is by pleasing not necessarily all the voters, but the patrons and possible patrons. The fact remains, however, that the primary object in the two cases is different and that we cannot compare the economics of the two systems until one or the other of these ends or some intermediate one is made our standard. Perhaps we may say that the primary end is to protect the capital invested, whether private or public, and, if it be private, to secure a reasonable return upon what has been necessarily and legitimately expended, and that the further end is to render a satisfactory service to the consumers, who may often be substantially the entire public. If this be admitted, it follows that the true end is not that of the ordinary corporation or of the ordinary municipal enterprise, and that the former is likely to neglect the interests of the consumers and the latter to risk the capital of the taxpayers.

Furthermore, the consumers may be grouped into two classes, the municipality as a body and the private citizens as individuals, and the balance must be held between these two interests which are often antagonistic. It is not, I believe, uncommon for a private corporation seeking a contract or franchise to offer unduly favorable terms to the municipality

and recoup itself for losses thus incurred by unduly high prices to individual patrons. Municipal enterprises, on the contrary, are tempted to close contracts with private patrons at a losing figure and let the municipality as a whole make up the losses. The true end of such a service, then, whether municipal or private, is, first, to guard the capital invested and secure it, if private, a fair return, and then to render the best possible service to all classes of consumers at the lowest remunerative rates.

It is unnecessary to argue here that in the fields under discussion competition is an inadequate controller of price and so an unsatisfactory defense of the consumer. The various forms and degrees of governmental control and also governmental ownership are devices to secure the results obtained in other fields through competition. These devices have been introduced as the conviction has been forced upon the community that competition was here ineffective. Hence it would seem to be reasonable that the study, following the sequence of events, should start with an analysis of earlier methods and proceed from unregulated private control through the various forms of governmental regulation or supervision to governmental management. The American people, I believe, are averse to governmental ventures into industrial fields, although that aversion may be decreasing. At the same time they can hardly approve of the results of unrestricted freedom in the field of natural monopolies.

If a comparison between municipal and private enterprises is to be instituted, the facts of importance must be ascertainable in a form admitting of comparison. It is doubtful that this requisite can be satisfied with regard to the majority of private enterprises, and the doubt is strengthened by the fact that the officials who prepared and published the Eleventh Census of the United States were unable to secure returns from one-fourth of the gas companies of the country including many large establishments, and published returns regarding electric lighting only for New York state, the District of Columbia, and the city of St. Louis. Probably a larger proportion of the companies would

refuse to answer the inquiries of private individuals who were seeking to test their efficiency as compared with municipal plants. While the facts touching municipal plants are usually published, they are not presented in a lucid fashion or with the explanations needed for their proper interpretation. Neither are the facts for different cities given according to any uniform method. An investigator in this field can hardly escape blunders in the chaos of municipal finances, and the suspicion is sometimes aroused that the figures are made deceptive with intent to mislead the public. At the best their being open to question is as fatal as their being intentionally misleading. Therefore there is little hope for a trustworthy answer to the question under discussion until both private and public corporations are compelled to keep their books by a uniform prescribed method and to publish the important facts annually. Such a law would be hard to pass and harder to enforce, but without it all methods must be tentative and imperfect. It may be in place here to mention that at a convention of the officials of the Bureau of Statistics of Labor held at Albany last June it was unanimously voted to undertake a cooperative investigation of the municipal ownership of water, gas, and electric-light plants and a committee of experienced statisticians was appointed to prepare a uniform schedule or schedules of questions. It will be of interest to see how far these officials succeed in securing the desired information in form admitting the institution of comparisons and the induction of inferences.

Again the student of any particular form of municipal enterprise must be or become familiar with its technical processes. Like a lawyer he must get up his case carefully and thoroughly, if his analysis and criticism are to be of value. Much popular discussion of municipal enterprises for profit has been valueless or inconclusive, because of failure to conform to this elementary requirement. As no one can become an expert in all these fields, the need of competent advice upon all technical processes and accounts is obvious.

The arguments upon the profitableness of municipal owner-

ship differ so widely in the various enterprises, that a statistical examination must lose in thoroughness and range if it seeks to include several classes under a single investigation. From the point of view of method, therefore, it would seem better to make a separate statistical study for each industry affording the requisite information. While administrative considerations may have prevented, it would seem theoretically better had the bureaus of labor decided to make one report upon private and municipal water works and a second upon private and municipal lighting.

Since the methods to be employed must differ in detail with the various enterprises, it seems best to limit the further discussion to a single industry which may be deemed typical. For this purpose gas lighting has been chosen as the one upon which the greatest amount of trustworthy information is available.

If private and municipal gas plants are to be compared with reference to their economic productivity, certain units of measurement should be fixed at the start. Now it is of the essence of a scientific unit that for the purpose in hand one unit should be the approximate equivalent of any other. Yet in popular discussions this prime requisite of sound statistical work is often neglected. Thus a ton of coal is a unit frequently employed, but to the gas manufacturer it is grossly inaccurate, because the quality of the coal—its gas-yielding power, and the character of the residuals—is extremely variable and is almost as important to him as its quantity, but far less susceptible of measurement. So, too, a thousand cubic feet of illuminating gas is a popular unit, but the quality of the gas—its constituents, candle power, and degree of purity—is almost as variable as that of coal.

In discussions of the economic productivity of municipally owned gas works a comparison of the present condition of municipal and private plants should be held subordinate to a study of the changes that are in progress and the tendencies to change which are inherent in the various systems. The emphasis has often but wrongly been laid upon a comparison of the present condition, partly because that is the more easily made,

but partly, also, I am convinced, because the fact has been ignored that no system is a stable one, but that, on the contrary, every system is steadily undergoing modifications so far reaching as to be of greater moment than the present conditions. These changes are complex and often elusive. Many must escape the notice of the student. But certain ones may be pointed out. The facts regarding the gas companies of Massachusetts have been gathered now for ten years, and evidence of certain changes may be derived from a collation of the facts contained in the eleven annual reports of the board of gas and electric light commissioners of that state.

The manufacture of coal gas has increased with great rapidity from 2,624,570,655 cubic feet in the year ending June 30, 1886, to 4,810,048,617 cubic feet in the year ending June 30, 1895, an increase of over two and one-sixth billion cubic feet or 83.3 per cent. in nine years.

While the output of coal gas has thus nearly doubled, the manufacture of water gas has sprung up from almost nothing. In the year ending June 30, 1887, only 28,354,300 cubic feet of water gas were made, but eight years later the reported output was over eighty-five times as great, 2,413,265,558 cubic feet, almost exactly one-half the amount of coal gas produced the same year. The system of electric lighting has also developed from almost nothing during the same period. Yet notwithstanding these powerful rivals and competitors, the output of coal gas increased about five-sixths in nine years.

Still the gas unaccounted for and presumably lost through leakage has remained nearly stationary, increasing in eight years (1887-95) less than 6 per cent. (5.9 per cent.), or perhaps one-twelfth as fast as the total product. The proportion of unaccounted-for coal gas to the total output was about one-twelfth (8.44 per cent.) in 1886-7, and but little over one-twentieth (5.14 per cent.) in 1894-5. The following table gives the figures for all the companies which produced over fifty million cubic feet of gas in 1894-5 and for which the facts are published:

PER CENT. OF GAS UNACCOUNTED FOR.

Company	1885-1886	1894-1895	Decrease	Increase
Boston.....	6.4	3.4	3.0	....
Brookline.....	15.7	7.2	8.5	....
Lowell.....	6.1	4.5	1.6	....
Roxbury.....	4.7	2.9	1.8	....
Cambridge.....	11.1	8.1	3.0	....
Worcester	7.9	8.1	....	.2
Dorchester.....	11.8	5.9	5.9	....
Springfield.....	7.0	8.5	....	1.5
Charlestown.....	11.5	6.9	4.6	....
South Boston.....	9.5	8.3	1.2	....
Lawrence.....	11.2	8.6	2.6	....
Newton	10.4	7.7	2.7	....
Haverhill	4.4	6.6	....	2.2
Fall River	13.0	6.7	6.3	....
Jamaica Plain.....	17.4	14.1	3.3	....

As will be seen from the preceding, twelve of the fifteen largest companies showed a decrease in the proportion of gas unaccounted for varying between 1.2 and 8.5, while only three showed an increase. The average increase of the three was only about one-third of the average decrease of the twelve.

While the output of gas has been rapidly increasing and the loss by leakage has fallen off, the quality of the gas has been improving. Quality is tested partly by the illuminating power of the gas in units of the illuminating power of standard sperm candles and partly by the number of grains of various impurities found in 100 cubic feet of gas. The average candle power of the coal gas in Massachusetts has risen from 17.6 in 1885 to 19.3 in 1895, and the illuminating power of the gas produced by the largest companies has increased yet faster. The following table gives the increase of candle power in ten years for each company producing over one hundred million cubic feet of gas in 1895.

Boston - - -	5.4	Cambridge - - -	.7
Brookline - - -	9.5	Worcester - - -	1.6
Lowell - - -	3.0	Dorchester - - -	7.2
Roxbury - - -	5.6	Lynn - - -	.7

The average increase of these large companies was 4.2 candle

power, or about two and one-half times the average for the entire state. Meanwhile the two impurities, sulphur and ammonia, referred to in the reports of the gas commissioners, have been decreasing perceptibly although irregularly.

The average amount of gas taken by each consumer has not materially changed during the eight years, 1887-95. The averages for the state are not obtainable, but twenty-six companies show an increase and thirty a decrease of this average. This, however, is consistent with an increase in the average amount taken by small consumers offset by a withdrawal of patronage by certain large consumers. What the facts may be the reports do not indicate.

During the same eight years the number of high-power gas lamps (Lungren, Albo-Carbon, and Welsbach) has risen from 1116 to 12,489, and the greatest amount of that increase has come in the last year, during which the increase was 4700 or 63 per cent.

The number of gas stoves reported as in use is also growing with great rapidity. Between 1894 and 1895 it rose from 15,877 to 42,412, an increase of 167 per cent.

The notable increase in the consumption of coal gas has gone on in the face of the competition of the electric lights. How keen that competition has been in Massachusetts is apparently indicated by the steady decrease, year by year, in the number of public lights burning coal gas. It diminished from 19,802 in 1885-6 to 11,946 in 1894-5, a falling off of nearly two-fifths (39.6 per cent.) in nine years.

These changes, whereby the municipalities take a smaller proportion of the coal gas and private consumers more, may affect materially the theoretical arguments concerning municipal ownership of gas, but with those this paper is not concerned.

Closely related to the foregoing modifications is one more important to the general consumer, viz., the reduction in price. The Massachusetts gas commissioners divide the coal gas companies by implication into two classes, large and small, and draw the line between them at an annual output of thirty million cubic

feet of gas. This makes three classes, the large coal gas companies, the small coal gas companies, and the oil gas companies. For each of these the average price of gas per thousand cubic feet has been reported for each year since 1887. The facts are collated in the following table:

Date	Average Price of Coal Gas		Average Price of Oil Gas
	Large Companies	Small Companies	
1887.....	\$1.59	\$2.17	\$4.13
1888.....	1.50	2.26	4.26
1889.....	1.45	1.93	4.16
1890.....	1.39	2.02	3.81
1891.....	1.31	1.96	3.76
1892.....	1.32	2.01	3.75
1893.....	1.27	1.94	3.74
1894.....	1.20	1.79	3.81
1895.....	1.03	1.74	3.90

The large companies sold gas in 1895 on the average 56 cents cheaper per thousand cubic feet than they did in 1887, the smaller companies sold it 43 cents cheaper, and the oil gas companies sold it 23 cents cheaper. But, as the prices of the smaller companies were originally much higher, the reductions made by the large companies involved a fall of 35 per cent. from the price in 1887, that of the small companies a fall of 20 per cent., and that of the oil gas companies of only 5½ per cent.

These reductions in price must have been affected by the prices of coal, but upon that point, unfortunately, the reports of the gas commissioners are silent, and I have not been able to secure the facts elsewhere. One important change, however, may be traced through the reports, and that is an increasing income from the sale of the residuals. For each year the companies report the percentage of the cost of their coal which was obtained for their residual products. It has quite uniformly increased. Between 1886 and 1895 thirty-eight companies showed an increase and only five a decrease. The results are not given in such a form as to make the average for the entire state obtainable from them, but the facts for all the companies

producing over fifty million cubic feet of gas in 1895 are included in the following table :

Companies in Order of Size	Per cent. of cost of coal obtained from sale of residuals in		Increase	Decrease
	1885-1886	1894-1895		
Brookline	29.9	60.5 ('93-'4)	30.6	....
Lowell	53.6	55.6	2.0	....
Cambridge.....	33.3	62.3	29.0	....
Worcester	26.6	24.3	....	2.3
Lynn.....	35.3	59.7	24.4	....
Springfield	37.2	48.5	11.3	....
Charlestown	45.8	54.5	8.7	....
Lawrence.....	43.0	84.0	41.0	....
Newton	29.4	54.0	24.6	....
Jamaica Plain.....	31.0	49.5	18.5	....
Holyoke	37.1	44.0	6.9	....

If an average of the preceding percentages be taken without regard to the varying amount of gas produced, it appears that in 1886 these large companies received 36.6 per cent. of the cost of their coal from the sale of residuals, and in 1895 they received 54.5 per cent., the improvement being thus equal to over one-sixth of the cost of the coal.

I may briefly recapitulate the changes which by way of extended illustration have been shown to have occurred, and presumably to be still progressing in Massachusetts, and not improbably elsewhere under the system of private control subject to state supervision.

(1) The manufacture of coal gas increased five-sixths in nine years.

(2) The proportion of this gas unaccounted for and so attributable to leakage has fallen to about three-fifths of what it was eight years ago.

(3) The quality of the gas has improved, especially in the case of the larger companies.

(4) The number of high-power gas lamps and of gas stoves has been rapidly increasing.

(5) Meanwhile the number of public gas lights has fallen about two-fifths.

(6) The price of gas has been falling, especially among the larger companies.

(7) The proportion of the cost of coal obtained from the sale of residuals has been rising.

Now the point upon which emphasis is to be laid is that the changes to which every sort of enterprise is subject and of which the foregoing are illustrations, are of far greater importance in the determination of its real economic productivity than the condition of that business at any point of time. Assume for the moment that all these gas companies had been managed for the last decade as municipal enterprises, would the same changes have taken place? If not, would those that did occur have resulted in a greater or in a less economic productivity? Such questions, it appears to me, are speculative and will be answered by everyone in accordance with preconceived ideas or theoretical arguments. I see no way in which to wring a conclusive answer to them from experience. Accordingly the answer which as a statistician rather than a theorist I am compelled to make to the question at issue is, in the first place, that until municipal enterprises have had a longer history, and the facts have been gathered and presented in a shape suitable for comparison, no method of determining their economic productivity will give convincing results, and that, secondly, when the facts are obtainable, the conclusions must be drawn from the changes which are fostered by the various systems, and that the conditions prevailing under any one at a particular time must be deemed of subsidiary importance.

WALTER F. WILLCOX.

CORNELL UNIVERSITY.